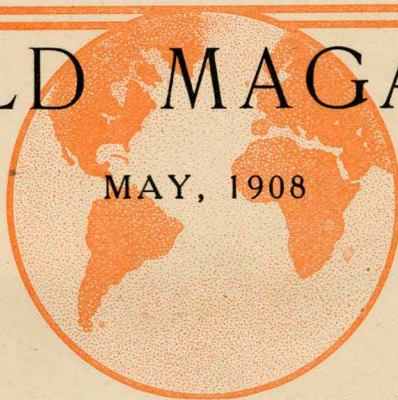


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THE ROMANCE OF TRANSMISSION

By GEORGE FREDERIC STRATTON

CAUTIOUSLY trailing through some shadowy canyon of the Sierras, perhaps with treacherous footing along the bed of a turbulent mountain stream, sheer, craggy walls of rock rising on either side to sixty, eighty, or one hundred feet, from which every vestige of living green has been torn by the spring torrents and above which again mount three or four hundred feet of steep, forest-clad slopes, the keen eye of hunter or prospector may sometimes light upon two or three wires swinging in a crescent high above the feathered tops of the pines. The span from supporting peak to supporting peak may be two hundred or two thousand feet.

If the explorer is a stranger and unacquainted with the peculiarities of the country his first thought will be of telegraph or telephone. But the old hand knows better and, if a hunter, will probably ejaculate with an oath: "Transmission!"

For they do not like the coming of the

wire—these rugged old slayers of bear and antelope—even though for many miles to east or west there be no other sign of civilization, save those little overhead wires and the roughly cleared strip beneath them. They assert that the antelope will never cross under the wire unless panic-stricken, and that the bear even avoids the shadow of it.

The trail which leads to the distant power-house may be a dozen miles from the transmission line. "Straight away," is always the motto for the wire, while the trail laid out for the transportation of heavy machinery and supplies back into those wild foot-hills must wind in devious ways to avoid alike the deep gulches and the high peaks.

The man who wishes to obtain the finest view of the achievement of engineers and construction parties will find it by journeying along the transmission line. It is not much easier traveling, as now laid out, than when the surveyors worked through. But for every mile you now travel they explored perhaps ten or twenty. The crossing of the canyon at the point where you scramble out has



NIAGARA POWER LINE ENTERING SYRACUSE, N. Y.

probably been selected from many which have been gropingly explored by those pioneers who, baulked by the difficulties ahead, have turned back again and again to search for an easier and more practicable path.

But you find the trail blazed, unmistakably. Above is the wire; below, except in the deepest gulches where the great redwood tops sway far below the sagging line, there is always a strip of clearing wide enough to prevent the trees, which fall during the fierce mountain storms, from colliding with the wires.

Notwithstanding this plainly blazed trail, the travel will call for the toughest muscles and endurance. It will be a good country where more than ten miles a day can be covered by seasoned men. Sometimes a rough ladder will be found securely fastened to the face of a perpendicular ledge. Perhaps you will find,

swinging across some deep, narrow canyon, a steel cable under which runs a basket in which, pulling yourself hand over hand, you may cross. These have been left from the construction outfit and are still maintained in good order for the use of the line patrol.

On a quiet day with a favoring breeze you will catch the swish and rush of water a mile or more before you reach the power-house; but, although the sound intensifies into a strident roar as the distance lessens, this by no means prepares the newcomer for the scene which opens before him as he breaks through the last thicket of under-brush and, from a boulder and stump-strewn side hill, gazes down upon the astounding picture. Out from the bowels of the rough building, picturesque even in its ugliness, belch forth gleaming, horizontal columns of water, big as barrels, with a force, speed and roar as though discharged from giant

cannon. Straight across the tail-race they gleam and quiver for two hundred feet, impinging upon a solid ledge of granite in which they have worn huge caverns. The spray dashes up the face of the bank for sixty or seventy feet. Up and down the stream, swirling and writhing, in a thousand rushing, crowding whirlpools, the water just freed from its maddening confinement is seeking to make good its escape. It is jammed back into the upper race and for a score of yards you will see it hanging, ledge upon ledge, fighting, snarling, surging and struggling for its chance to slip beneath those terrific outlet volleys and gain the lower stream—and liberty, and peace.

The visitor would do well to halt, for an hour at least, and drink in every detail of this wonderful scene. The mighty Niagara itself has no such background of wild beauty—nor does it even convey such an instant impression of water force, and this first impression will never be surpassed or even equalled if you should visit the scene a score of times.

Presently, descending to the power-house, you see the great generators, whirling—and humming like giant June-bugs. From the windows at the back of the building you look up a hill six or seven hundred feet in height, the narrow trail to the crest lined by the pines, and, lying in that trail are the penstocks or flumes—24-inch steel tubes, black, ungainly and, at twilight, uncanny. They follow in curves the profile of the rough ground and look like elongated snakes, poking inquisitive noses into the power-house foundations—fitting things, however, if man's work must be brought into these hills, for the weird, mysterious strangeness of the surroundings.

Leading from the generators and out of one end of the building are the conducting wires. Just outside is the first pole and then away through the dense woods and wild hills the line runs for sixty miles, ending in a bustling city.

Again you glance at the penstocks, and then, from the opposite windows, you look down upon those terrific volleys



MEALS ARE BROUGHT TO THE WORKMEN IN THEIR CAMP BY MEANS OF PACK HORSES.



POWER HOUSE. LOOKING UP-STREAM—TWO GENERATORS IN OPERATION.

of water. Drop a plank into one of them, end down, if you wish. The eye can scarcely follow it when it strikes and you only know by the splinters and chips you afterwards find in the lower reach of the tail-race that it was smashed

against the opposite ledge as though hurled by dynamite. Each of those volleys of water is equal to more than one hundred of the highest type of steam fire-engines, and the force is far greater. If one of them could be directed against

any brick dwelling it would raze it to the ground in a few moments. A frame house would go down like a pyramid of matches.

And yet, notwithstanding the speed with which that water is rushing from the turbines, before it has reached the opposite rock the power it has generated has beaten it by sixty miles and is, at that instant, hauling scores of street cars and turning numberless factory wheels. It is hard to realize this, and impossible to understand it—no man has yet done that—and under no circumstances where power is developed is this realization so difficult as at one of these mountain power-houses. You see, from your vantage point, the actual rush, turbulence, and immensity of the power used. Dazed and fascinated, you almost doubt the possibility of control over any such wild force and yet, with a slight turn of the eyes you see the tiny, silent, unobtrusive wire which carries almost the whole of it so swiftly, so surely, and so mysteriously. You have blind faith in the accomplishment, but reason based upon any experience whatever is staggered.

Men of morbid temperament have gone mad contemplating this mystery. When a plant has settled into smooth, working conditions and the engineer's duty is chiefly to watch, there is much time for solitary thought. The wild, weird surroundings and the rush of water day and night, the never-ending, steady whirl of the armatures, and the sputtering of the wicked little blue sparks at the commutators sometimes get on a man's nerves. At one of the Colorado plants the engineer in charge, armed with two heavy revolvers, fastened himself in the power-house, pulled out all the line switches and, firing a shot at his assistant outside, announced that he had cut out the conductors and intended to "see what the d—d juice was going to do with itself!" then, lying down comfortably upon a bale of waste, he plugged bullets into the telephone and through whatever window his distracted assistant tried to argue with him. For five hours he held the fort, and cars and work-shops in a distant city were stopped; then he dropped asleep and the assistant crept in through a window and

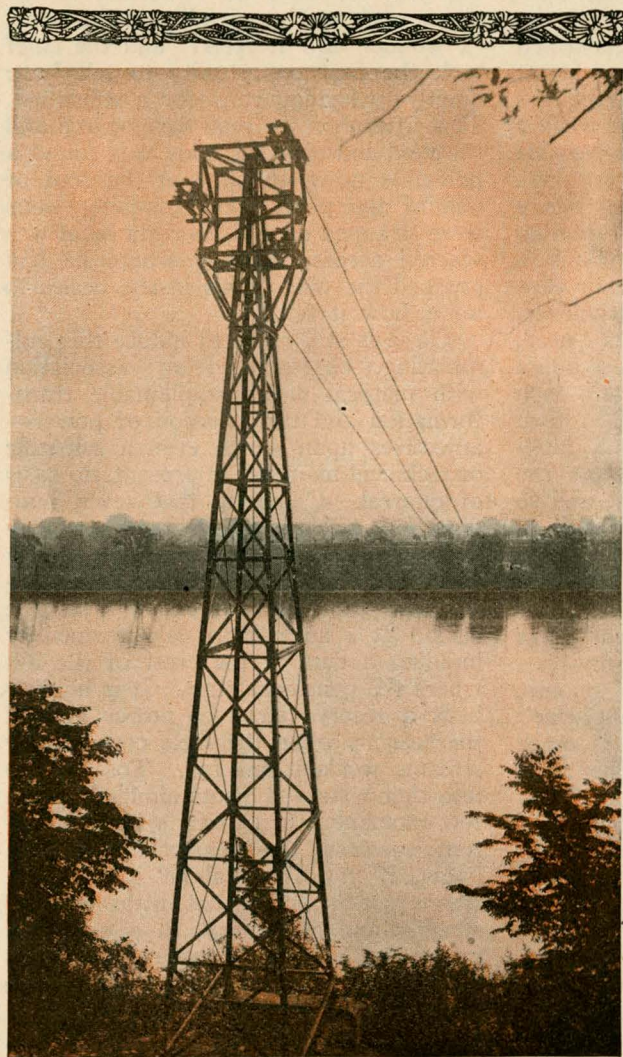
threw in the switches just before a relief party arrived on horse-back.

At another plant an assistant had suddenly expressed some doubts about the wires carrying the "juice." Twice during one forenoon he remarked to his chief, while gazing steadily at the wire: "I wonder how it feels!" and the chief took the first opportunity to telephone quietly to headquarters for a substitute. That afternoon the man disappeared and the next morning his body was found a half-mile down the line at the foot of one of the poles. His climbing irons were strapped on and his right hand was scarred across, showing where he had grasped the wire in his insane desire to know how it felt.

There is still more to induce this culminating obsession from association with magical and unexplainable transformation and transmission of power—adjectives upon which even a scientific or technical man has, at present, no basis of quarrel. Climb up that seven hundred foot hill and at the crest you may look upon a little lake, as placid as any water gem of Maine, Michigan, or Wisconsin. The engineers call it a storage basin. It is an artificial lake formed by building a dam at the crest of the hill where the penstocks start. It is holding back a reserve store of power against the seasons when the little contributory streams weaken and fail. Toss a chip into that water—it floats aimlessly for a few moments, then drifts with the current towards the penstocks and you know, if you think about it, that the water which floats that little chip so steadily and easily will, in a very few moments, be running crowded cars through crowded streets in a city one hundred or more miles away.

Romantic and unscientific, of course, but he is a very self-contained and unimaginative engineer or assistant who has had experience with mountain water-power transmission and never viewed cause and result except as a machine operation. Until it is all reduced to hard, incontrovertible deduction of fact and mathematical formula there will always be the unscientific haze of speculation and the halo of romance about the marvelous agent, whether it be used to convey fifty thousand horse-power for

hundreds of miles through a wire no larger than a man's finger—or commercial messages through three thousand miles of space with no wire at all.



SPAN OF WIRES ACROSS THE CONNECTICUT RIVER AT THOMPSONVILLE, CONN.

Although the transmission line begins at the power-house the source of the water may be ten, twenty, or thirty miles farther up the mountain range. At Mount Rainier, in Washington, whose

rugged peak—the highest in the country—is always capped with ice and down whose sides, above the timber line, are slowly shifting and dissolving glaciers, there are several great power-houses situated in the foot-hills. They obtain their water supply through from five to fifteen miles of flume or artificial conduit which start far up the slopes of the mountain, thus securing great heads of water.

The Pacific Coast may well be called the nursery of transmission. Although not the birthplace, its necessities and its opportunities led to the earliest developments for the utilization of water-power which was more or less remote from the industries which demanded it. Transmission lines up to one hundred miles in length are common, and in Northern California one company claims to have nearly one thousand miles of such lines in constant operation. This, however, comprises a number of branches, several power-houses and sub-stations. It must not be understood as straight-away transmission.

East of the Rockies by far the greatest transmission exploit is that of the Niagara, Lockport & Ontario Power Company. This draws over thirty thousand horse-power from the Niagara river and transmits it one hundred and sixty-five miles to Rochester, Syracuse and intermediate towns.

The power is generated on the Canadian side; and upon the conception of the project the question was raised as to the admissibility of "juice" into this country without paying duty. The matter was happily settled by the



A GROUP OF ENGINEERS IN THE FOREST-COVERED MOUNTAINS.

decision of the authorities that electric current could nowhere be found on the tariff schedules.

The construction of this line is of a highly developed and very substantial character. For the greater portion steel towers are used instead of the usual

poles, and the ordinary span is five hundred and fifty feet, although at certain crossings of small lakes or swamps spans up to twelve hundred and fifty feet are found. The conducting cables are of aluminum, the largest consisting of nineteen strands. The insulators used on

this, as on all other high voltage lines, are surprisingly large compared with those used commonly to support telegraph or lighting wires. They are as high and as large around as nail kegs and weigh upwards of one hundred pounds each, and the necessity for such dimensions will be fully appreciated when it is considered that upon the insulators depend the safety and stability of the whole line. The strain upon them in supporting spans of five hundred and fifty feet or more of heavy wire, subjected at times to wind pressure of possibly sixty miles per hour, while coated thickly with ice, is enormous. Added to this is the absolute necessity for such designs of form as will eliminate any possibility of current-jumping through moisture on the insulator during a driving rain. Current at sixty or seventy thousand volts is terribly elusive and the practical limit, at present, of high voltage at those figures is claimed by many engineers to be due, not to the transformers but to a cautious hesitancy about throwing any more strain on the insulators.

This Niagara, Lockport and Ontario line is also remarkable for the work it is now doing and will do in the near future. At present it is running the street cars of Syracuse, one hundred and sixty-five miles from the generators; it is furnishing a large amount of power to Rochester industries, and to a score of towns in the vicinity of its long line. Within a year sixty thousand horse-power will be transmitted, and its equipment is at most points designed for an ultimate increase to one hundred and eighty thousand horse-power.

The simple view of a transmission line in any location is not particularly impressive, and gives but little idea of the immense difficulty which has sometimes been encountered in its erection. The North Mountain line, from Canyon creek to Eureka, California—sixty miles—in its construction called for as great endurance, resource, ingenuity and patience as has ever been demanded in a similar length of mountain railroad construction. The feats of railroad engineering design and audacity were not exhibited, but those of surveying and constructing were fully equalled if not surpassed.

This will be understood upon considering that at every point of railroad construction, immediately behind the workers, is a graded road, ironed and equipped with locomotive power, to bring up the supplies. The men advance only so fast as they build the road. But with a transmission line it is vastly different. It is always imperative that it should be carried as the crow flies. A straight line means less copper and the elimination of severe side strains on the supporting poles. In the sixty miles of the North Mountain line it deviates less than two miles from an absolutely straight line. It is carried across the roughest country that the foot of man has ever scrambled over. Eureka is at sea level; the power-house is 1,480 feet above, and between the two are three divides ranging from 4,500 to 5,500 feet in height. The line had to be taken over these almost impassable peaks, yet there was no attempt at a road, and scarcely a trail. Every pound of material and supplies had to be packed on mule back for the entire distance. Excepting for the clearance of the timber from a strip three or four hundred feet in width immediately beneath the line, the trail was, and now is, as rough and difficult as before any civilized man ever went through.

It was scramble, climb, and dodge boulders for every yard of that sixty mile stretch. Very narrow, deep gulches were roughly bridged, others were crossed by means of wire cables carrying a freight basket in which men and material were borne—and, when necessary, mules also in slings. The timber was heavy, consisting of white pine, spruce, and red-wood. In the red-wood belt trees twelve feet in diameter were found, and the average size of those felled was four feet. The cooking outfit was seldom moved, it being easier to send prepared food to the men by pack-horse, the working gang shifting their small sleeping tents as the work advanced. Yet this entire line was strung up in four months! To see the topography of the country and know the operating facts is to appreciate the high type of executive ability which was engaged in the work.

For the power-house a road was roughly constructed, this of course being

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